

JC08 Rec'd PCT/PTO 26 JAN 2001

FORM PTO-1390  
(REV 10-2000)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

P/3501-9

**TRANSMITTAL LETTER TO THE UNITED STATES  
DESIGNATED/ELECTED OFFICE (DO/EO/US)  
CONCERNING A FILING UNDER 35 U.S.C. 371**

U.S. APPLICATION NO. (If known, give 37 CFR 1.5)

09/744613

INTERNATIONAL APPLICATION NO.  
PCT/US99/16968

INTERNATIONAL FILING DATE  
28 July 1999

PRIORITY DATE CLAIMED  
28 July 1998

TITLE OF INVENTION  
ENHANCEMENT OF PROFILED TUBULAR LINING SYSTEMS BY CHANNEL AUGMEN-

APPLICANT(S) FOR DO/EO/US Jack Curtis TAYLOR et al. TATION

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to promptly begin national examination procedures (35 U.S.C. 371(f)).
4. ☐ The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
  - a. ☐ is attached hereto (required only if not communicated by the International Bureau).
  - b. ☒ has been communicated by the International Bureau.
  - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
  - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
  - b. ☒ have been communicated by the International Bureau.
  - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
  - d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). - **unsigned**
10. ☒ ~~XXXXXXXXXXXXXXXXXXXX~~ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 16 below concern document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98. **and 4 references.**
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.  
☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information:  
14 sheets of drawings.  
PCT International papers.  
PEFS form.

EXPRESS MAIL CERTIFICATE

I hereby certify that this correspondence is being deposited with the United States Postal Service as Express Mail Post Office to Addresses (mail label EL583738841US in an envelope addressed to: Asst. Commissioner for Patents, Washington, D.C. 20231, on **January 26, 2001**

**Dorothy Jenkins**

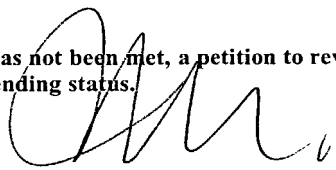
Name of Person Mailing Correspondence

*Dorothy Jenkins*  
Signature

**January 26, 2001**

Date of Signature

500 Rec'd PCT/PTO 2 6 JAN 2001

U.S. APPLICATION NO. (37 CFR 1.53) <b>097744613</b>		INTERNATIONAL APPLICATION NO. PCT/US99/16968		ATTORNEY'S DOCKET NUMBER P/3501-9	
17. <input checked="" type="checkbox"/> The following fees are submitted: <b>BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :</b> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO ..... <b>\$1000.00</b> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO ..... <b>\$860.00</b> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... <b>\$710.00</b> International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) ..... <b>\$690.00</b> International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) ..... <b>\$100.00</b> <div style="text-align: right;"><b>ENTER APPROPRIATE BASIC FEE AMOUNT =</b></div>				<b>CALCULATIONS</b> PTO USE ONLY           	
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				\$ 100.00	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	45 - 20 =	25	X \$18.00	\$ 450.00	
Independent claims	7 - 3 =	4	X \$80.00	\$ 320.00	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ \$270.00	\$	
<b>TOTAL OF ABOVE CALCULATIONS =</b>				\$ 870.00	
<input checked="" type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				\$ 435.00	
<b>SUBTOTAL =</b>				\$ 435.00	
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$	
<b>TOTAL NATIONAL FEE =</b>				\$ 435.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property				\$	
<b>TOTAL FEES ENCLOSED =</b>				\$ 435.00	
				Amount to be refunded: \$	
				charged: \$	
a. <input checked="" type="checkbox"/> A check in the amount of \$ <u>435.</u> to cover the above fees is enclosed. <b>Check No.</b> <u>3120</u>  b. <input type="checkbox"/> Please charge my Deposit Account No. _____ in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed. c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. <u>15-0700</u> . A duplicate copy of this sheet is enclosed.					
<b>NOTE:</b> Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.					
SEND ALL CORRESPONDENCE TO: <b>OSTROLENK, FABER, GERB &amp; SOFFEN, LLP</b> <b>1180 Avenue of the Americas</b> <b>New York, NY 10036-8403</b>  <b>Tel: (212) 382 0700</b>					
				<div style="text-align: center;">             SIGNATURE  <b>James A. Finder</b>            NAME  <u>30,173</u>            REGISTRATION NUMBER         </div>	



JC04 Rec'd PCT/PTO-1 3 APR 2001

P/3501-9

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of

Jack Curtis TAYLOR, et al.

Date: April 10, 2001

Serial No.: 09/744,613

Group Art Unit:

Filed: January 26, 2001

Examiner:

Int'l App. No. PCT/US9916968

IA Filed: July 28, 1999

For: ENHANCEMENT OF PROFILED TUBULAR LINING SYSTEMS BY CHANNEL AUGMENTATION

Asst. Commissioner for Patents

Washington, D.C. 20231

**PRELIMINARY AMENDMENT/SUBMISSION**

Preliminary to examination of the above identified application, please amend as follows:

**FEE CALCULATION**

Any additional fee required has been calculated as follows:

\_\_\_\_\_ If checked, "Small Entity" status is claimed.

NO. CLAIMS AFTER AMENDMENT	HIGHEST NO. PREVIOUSLY PAID FOR	EXTRA PRESENT	RATE	ADDIT. FEE
TOTAL	MINUS	* =	X (\$9 SE or \$18)	\$
INDEX.	MINUS	** =	X (\$40 SE or \$80)	\$
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM			X (\$135 SE or \$270)	\$
* not less than 20 ** not less than 3				TOTAL \$

If any additional payment is required, a check which includes the calculated fee of \$ \_\_\_\_\_  
(OFGS Check No. \_\_\_\_\_) is attached.

In the event the actual fee is greater than the payment submitted or is inadvertently not enclosed or if any additional fee during the prosecution of this application is not paid, the Patent Office is authorized to charge the underpayment to Deposit Account No. 15-0700.

**CONTINGENT EXTENSION REQUEST**

If this communication is filed after the shortened statutory time period had elapsed and no separate Petition is enclosed, the Commissioner of Patents and Trademarks is petitioned, under 37 C.F.R. §1.136(a), to extend the time for filing a response to the outstanding Office Action by the number of months which will avoid abandonment under 37 C.F.R. §1.135. The fee under 37 C.F.R. § 1.17 should be charged to our Deposit Account No. 15-0700.

**AMENDMENTS**

☒ If checked, amendment(s) to the specification are submitted herewith.

1. ☐ If checked, an abstract is submitted as the last page of Appendix A.

**2. Specification:**

Please delete the paragraph bridging pages 1 and 2, and replace such paragraph pursuant to 37 C.F.R. § 1.121(b)(ii) with the “clean” version attached hereto as Appendix A. Entry is respectfully requested. A version with markings to show the changes made pursuant to 37 C.F.R. § 1.121(b)(iii) is attached hereto as Appendix B.

**REMARKS/ARGUMENT**

The language of the Summary of Invention was unclear as filed, and is being improved in this Preliminary Amendment.

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as First Class Mail in an envelope addressed to: Asst. Commissioner for Patents, Washington, D.C. 20231, on April 10, 2001:

James A. Finder

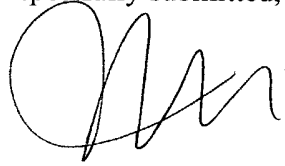
Name of applicant, assignee or  
Registered Representative

Signature

April 10, 2001

Date of Signature

Respectfully submitted,



James A. Finder

Registration No.: 30,173

OSTROLENK, FABER, GERB & SOFFEN, LLP

1180 Avenue of the Americas

New York, New York 10036-8403

Telephone: (212) 382-0700

JAF:db:swu

**APPENDIX A**  
**"CLEAN" VERSION OF EACH PARAGRAPH/SECTION/CLAIM**  
**37 C.F.R. § 1.121(b)(ii) AND (c)(i)**

**SPECIFICATION:**

Replacement for the last paragraph bridging pages 1 and 2 of the specification:

**SUMMARY OF THE INVENTION**

The invention described herein expands the range of possible applications of liners through utilization of longitudinally oriented members possibly disposed within channels in the surface of the liner body. The members advantageously may be used for pulling a liner into a host tubular, and/or for maintaining the structural strength of the liner. The embodiments of the invention further provide for continuity of the members along the length of the plastic-lined tubular, and if applicable, through intermediary joints.

**APPENDIX B****VERSION WITH MARKINGS TO SHOW CHANGES MADE****37 C.F.R. § 1.121(b)(iii) AND (c)(ii)****SPECIFICATION:****Paragraph bridging page 1 and 2:****SUMMARY OF THE INVENTION**

The invention described herein expands the range of possible applications of liners through utilization of longitudinally oriented members possibly disposed within channels in the surface of the liner body. The members advantageously may be used for pulling a liner into a host tubular, and/or for maintaining the structural strength of the liner. The embodiments of the invention further provide for continuity of the members along the length of the plastic-lined tubular, and if applicable, through intermediary joints.

09/744613 09/744613  
500 Rec'd PCT/PTO 26 JAN 2001

P/3501-9

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of

New York, New York

Jack Curtis TAYLOR et al

Date: January 26, 2001

Serial No.:

Group Art Unit:

Filed:

Examiner:

For: ENHANCEMENT OF PROFILED TUBULAR LINING SYSTEMS BY CHANNEL  
AUGMENTATION

Asst. Commissioner for Patents  
Washington, D.C. 20231

PRELIMINARY AMENDMENT

Sir:

Prior to examination, please amend the application as follows:

IN THE CLAIMS:

Please cancel claims 1-45.

REMARKS

Entry of replacement pages 14-20 containing claims 1-45 submitted on November  
13, 2000 with the Response to Second Written Opinion (attached) is requested.

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Commissioner for Patents, Washington, D.C. 20231,  
on January 26, 2001:

Dorothy Jenkins

Name of Person Mailing Correspondence

*Dorothy Jenkins*

Signature

January 26, 2001

Date of Signature

Respectfully submitted,

*James A. Finder*

James A. Finder

Registration No.: 30,173

OSTROLENK, FABER, GERB & SOFFEN

1180 Avenue of the Americas

New York, New York 10036-8403

Telephone: (212) 382-0700



P/3501-3

IN THE INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY  
UNITED STATES PATENT AND TRADEMARK OFFICE

In re PCT International Application of:

Safetyliner Systems, LLC

Date: November 13, 2000

Int'l. Appln. No.: PCT/US99/16968

Examiner: D. Hwu

Int'l. Filing Date: 28 July 1999

Art Unit: 3752

For: ENHANCEMENT OF PROFILED TUBULAR LINING SYSTEMS  
BY CHANNEL AUGMENTATION

Commissioner for Patents and Trademarks  
Box PCT  
Washington, D.C. 20231

VIA FACSIMILE: (703) 305-3230

RESPONSE TO SECOND WRITTEN OPINION

Sir:

A second Written Opinion was issued October 13, 2000.

In view of the claim amendments discussed below, replacement pages 14-20 containing claims 1-45 are enclosed herewith.

Patentable subject matter has been found in claims 4-20, 25, 26, 30, 34, and 41-45.

Claims 1-3 and 35-40 were rejected as being obvious in view of Wilson and Horner et al. In response, claims 1 and 35 are being amended to include patentable subject matter from claim 4 which is neither disclosed nor suggested by the cited art, namely the step of "pulling on said elongated member in order to pull said liner and said elongated member together into said tubular."

Therefore, patentable subject matter should be found in claims 1-3 and 35-40, in addition to claims 4-20 and 41-45.

Claims 21-24 were rejected as being anticipated by Foucras. In response, claim 21 is being amended to include patentable subject matter from claim 25, namely that "said

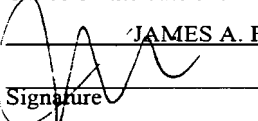
tubular system is assembled by the steps of securing said liner and at least one elongated member to each other; and then pulling on said member, so that said liner is pulled, along with said member, into said tubular." This feature is neither shown nor suggested by the cited art. Claim 26 is being rewritten in independent form. Therefore, patentable subject matter should be found in claims 21-24 in addition to claims 25 and 26.

Claims 27-29 and 31-33 were rejected as being obvious over Foucras in view of Louwagie et al. Claim 27 is being clarified slightly. Foucras relates to an active heating system which uses a heating cable inserted between the pipe and the outer cover. Louwagie discloses means for monitoring the pressure locally in a pipe by measuring a pressure differential between the atmospheric pressure and the inner pressure using a pressure transducer, for example a strain gauge pressure sensor. Louwagie contains no suggestion, nor any means, of detecting or determining the location of a blockage. The Examiner has not pointed out any portion of Louwagie containing such a disclosure. Louwagie may teach detecting an increase of pressure within the bore, but nothing in Louwagie would suggest, or make it possible, to determine and indicate the location of a blockage as claimed.

Therefore, patentable subject matter should be found in claims 27-29 and 31-33, in addition to claims 30 and 34.

In view of the foregoing, the Examiner is requested to reconsider his findings and issue a favorable International Preliminary Examination Report.

I hereby certify that this correspondence is being facsimile transmitted to the Patent and Trademark Office on the date shown below

 JAMES A. FINDER  
Signature

November 13, 2000  
Date

Respectfully submitted,



James A. Finder  
Registration No.: 30,173  
OSTROLENK, FABER, GERB & SOFFEN  
1180 Avenue of the Americas  
New York, New York 10036-8403  
Telephone: (212) 382-0700

WHAT IS CLAIMED IS:

1. A method of assembling a tubular system,  
the tubular system comprising a tubular; a liner in the tubular, the liner having an outer wall engaging an inner wall of the tubular, the liner having an inner wall defining a hollow bore; and at least one elongated member which is disposed between said liner and said tubular and defines a fluid flow passage between said liner and said tubular;  
said method comprising the steps of:  
placing said liner and said member in contact with each other;  
while said liner and said member are in contact, pulling on said elongated member in order to pull said liner and said elongated member together into said tubular.
2. The method of claim 1, wherein after said pulling step, said member is disposed between said outer liner surface and said tubular and thereby deforms said liner so as to define said fluid flow passage.
3. The method of claim 1, wherein said member is disposed in a channel which is formed in a surface of said liner.
4. The method of claim 1, further comprising the steps of:  
placing a predetermined initial stress on said liner so as to induce a strain; and then  
adhering said liner and said member to each other;  
wherein in said pulling step, said liner is pulled along with said member into said tubular without inducing substantial additional strain on said liner.
5. The method of claim 4, wherein said adhering step comprises the step of providing barbs on said member.
6. The method of claim 4, wherein said adhering step comprises the step of applying heat to said member.
7. The method of claim 6, wherein said adhering step further comprises the step of applying an adhesive between said member and said liner.

8. The method of claim 6, wherein said heat is applied by passing an electric current through said member.

9. The method of claim 6, wherein said heat is applied by radiation from the exterior of said liner.

10. The method of claim 4, wherein said adhering step comprises the step of applying an adhesive between said member and said liner.

11. The method of claim 4,  
wherein said member is disposed in a channel which is formed in said outer surface of said liner, and

wherein said adhering step comprises the steps of disposing said member in said channel, then radially compressing the liner so that said channel grips said member.

12. The method of claim 11, wherein said member comprises a cable.

13. The method of claim 11, wherein said member comprises a generally helical spring.

14. The method of claim 13, wherein said spring has a spring constant which is stiffer than a modulus of elasticity of said liner so that said liner is pulled by said member into said tubular without placing substantial additional strain on said liner.

15. The method of claim 11, wherein said member when in said channel is disposed fully inside said outer surface of said liner.

16. The method of claim 15, wherein said member is adhered to said liner sufficiently to remain in said channel.

17. The method of claim 11, wherein said member is adhered to said liner sufficiently to remain in said channel.

18. The method of claim 11, further comprising the step of making said member of a sufficiently strong material to resist deformation of said channel due to increased pressure in said liner bore.

19. The method of claim 11, further comprising the step of making said member of a sufficiently strong material to resist deformation of said channel due to thermal softening of said liner.

20. The method of claim 11, further comprising the step of making said member of a sufficiently strong material to resist deformation of said channel due to swelling of said liner upon contact with materials in said liner bore.

21. A tubular system with internal heating, comprising:

a host tubular;

a liner in the tubular, the liner having an outer wall engaging an inner wall of the tubular, the liner having an inner wall defining a hollow bore; and

at least one electrically conductive elongated member disposed between said host tubular and said liner;

said liner comprising an electrical heating element connected to said at least one member for receiving electrical current from said member and thereby heating said tubular system;

wherein said tubular system is assembled by the steps of:

securing said liner and at least one elongated member to each other; and

then pulling on said member, so that said liner is pulled, along with said member, into said tubular.

22. The tubular system of claim 21, the liner having at least one channel formed therein, said member being disposed in said at least one channel.

23. The tubular system of claim 22, wherein said electrical heating element is a conductive polymer layer which has an electrical resistance and forms a part of said liner.

24. The tubular system of claim 22, wherein said electrical heating element is an electrically resistive wire disposed in said at least one channel.

25. The tubular system of claim 21, wherein said tubular system is further assembled by the steps of:

placing a predetermined initial stress on said liner so as to induce a strain; and

then pulling on said member, so that said liner is pulled, along with said member, into said tubular without inducing substantial additional strain on said liner.

26. A tubular system with internal heating, comprising:

a host tubular;

a liner in the tubular, the liner having an outer wall engaging an inner wall of the tubular, the liner having an inner wall defining a hollow bore; and

at least one electrically conductive elongated member disposed between said host tubular and said liner;

said liner comprising an electrical heating element connected to said at least one member for receiving electrical current from said member and thereby heating said tubular system;

wherein said member is adhered to said liner and has sufficient tensile strength to be usable to pull said liner into said tubular without inducing substantial strain in said liner.

27. A tubular system adapted for determining the location of a blockage therein, the tubular system comprising:

a tubular;

a liner in the tubular, the liner having at least one channel formed therein; an outer wall of the liner engaging an inner wall of the tubular; the liner having an inner wall defining a hollow bore; and

at least one elongated sensing member which is disposed in said at least one channel and is responsive to pressure in said hollow bore within said liner, and produces a pressure

signal which is indicative of said location of said blockage.

28. The tubular system of claim 27, wherein said elongated sensing member comprises an electrical strain gauge.

29. The tubular system of claim 27, wherein said elongated sensing member comprises at least one optical fiber.

30. The tubular system of claim 27, wherein said member is adhered to said liner and has sufficient tensile strength to be usable to pull said liner into said tubular without inducing substantial strain in said liner.

31. A method of determining the location of a blockage in a tubular system, the tubular system comprising:

a tubular; and

a liner in the tubular, the liner having at least one channel formed therein; an outer wall of the liner engaging an inner wall of the tubular; the liner having an inner wall defining a hollow bore; said method comprising the steps of:

placing at least one elongated sensing member in said at least one channel, said sensing member being responsive to pressure in said hollow bore within said liner, said pressure being indicative of said location of said blockage;

applying an input signal to said sensing member; and

receiving an output signal from said sensing member and processing said output signal to determine said location of said location of said blockage.

32. The method of claim 31, wherein said sensing member comprises an electrical strain gauge and said input and output signals are electrical.

33. The method of claim 31, wherein said sensing member comprises at least one optical fiber and said input and output signals are optical.

34. The method of claim 31, wherein said tubular system is assembled by the steps

of:

placing a predetermined initial stress on said liner so as to induce a strain;  
then adhering said liner to at least one elongated member; and  
then pulling on said member, so that said liner is pulled, along with said member, into said tubular without inducing substantial additional strain on said liner.

35. A method of assembling a tubular system,  
the tubular system comprising a tubular; a liner in the tubular, the liner having an outer wall engaging an inner wall of the tubular, the liner having an inner wall defining a hollow bore; and at least one elongated member which is disposed between said liner and said tubular and defines a fluid flow passage between said liner and said tubular;  
said method comprising the steps of:  
placing said liner and said member in contact with each other;  
while said liner and said member remain in contact, pulling on said elongated member in order to pull said liner and said member together into said tubular.

36. The method of claim 35, wherein said contact between said elongated member and said liner protects said elongated member from deformation while being pulled into said tubular.

37. The method of claim 36, wherein said elongated member comprises a communications cable.

38. The method of claim 36, wherein said elongated member comprises a heating cable.

39. The method of claim 36, wherein said elongated member comprises a force-sensing cable.

40. The method of claim 36, wherein said elongated member comprises an electrical or fluid-carrying conduit.



41. A method of assembling a tubular system,  
the tubular system comprising a tubular; a liner in the tubular, the liner having an outer wall engaging an inner wall of the tubular, the liner having an inner wall defining a hollow bore; and at least one elongated member which is disposed between said liner and said tubular and defines a fluid flow passage between said liner and said tubular;

said method comprising the steps of:

placing said liner and said member in contact with each other;

while said liner and said member remain in contact, pulling said liner into said tubular;

wherein said contact between said elongated member and said liner protects said elongated member from deformation while being pulled into said tubular;

wherein said member is disposed in a channel which is formed in said outer surface of said liner, and

wherein said adhering step comprises the steps of disposing said member in said channel, then compressing said channel so that said channel grips said elongated member.

42. The method of claim 41, wherein said member and liner are pulled into said tubular with said channel still compressed.

43. The method of claim 41, wherein said channel is compressed by radially compressing said liner.

44. The method of claim 43, wherein said member and said liner are pulled into said tubular with said liner still compressed.

45. The method of claim 11, wherein said member and said liner are pulled into said tubular with said liner still compressed.

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500 Rec'd PCT/PTO 26 JAN 2001

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PCT/US99/16968

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Enhancement of Profiled Tubular Lining Systems by Channel Augmentation

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based on and claims priority from U.S. Provisional patent application 60/094,326 filed July 28, 1998, in the name of Jack C. Taylor.

This application is related to Serial No. 08/532,561 filed June 4, 1990, now U.S. Patent 5,072,622; and the following provisional applications, all filed in the name of Jack C. Taylor: Serial No. 60/093,665 filed July 22, 1998 and its corresponding PCT Intl. Appln. No. PCT/US99/\_\_\_\_\_, filed July 22, 1999; Serial No. 60/094,585 filed July 29, 1998; and Serial No. 60/138,814 filed June 14, 1999.

Some, but not all, of the aspects of the invention described herein have been filed under the USPTO Document Disclosure program by Jack C. Taylor, under reference numbers 403965 (August 28, 1996), 403966 (August 28, 1996), 413924 (July 21, 1997), 424712 (September 18, 1997), and 430792 (January 26, 1998).

The foregoing disclosures are incorporated by reference herein.

BACKGROUND OF THE INVENTION

Pipes and other tubulars have been lined with polymeric liners (e.g., polyethylene, nylon 11, etc.) for many years and several installation techniques are known to the art. These systems have been used principally in offshore and on shore pipelines, and in downhole production tubulars. Their scope has generally been limited to corrosion and erosion protection. However, they have also been used in monitoring for integrity of the composite liner-host system, as described in US Patent 5,072,622 (Roach & Whitehead).

Generally, the liner resides in close-tolerance with the host pipe along its length, forming a stable composite system, as shown in Fig. 1 which is, a cutaway end view of a tubular 10 with a liner 11. The installed liner may be either of a loose-fit or a compressed-fit variety, both well known to the art. In all but low pressure applications, the stresses induced by fluid pressure from within the liner are transmitted to the surrounding 'host' tubular, and resisted by the same. The liner acts as an intermediary layer.

SUMMARY OF THE INVENTION

The invention described herein expands the range of possible applications of liners through utilization of longitudinally oriented members possibly disposed within channels in the surface of

Figs. 15a and 15b are cross-sectional views showing respective examples of conductive polymer heating elements.

Figs. 16a, 16b and 16c, 16d and 17 are isometric and cross-sectional views showing differential stresses applied to cable members, Figs. 16a-16d showing a strain gauge cable and Fig. 17 showing a fiber optic cable.

Figs. 18a and 18b show an embodiment comprising conductive members disposed on a non-channeled liner within a host tubular.

Fig. 19 schematically illustrates an alternate embodiment with electrically conductive cable members and tracing cable heating elements in the liner.

#### DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

Figs. 2a-2c are cross-sectional views of a tubular 10, respective liners 12, 13 and 14, channels formed in the liners, and members disposed in the channels. In Fig. 2a the member 15 is a bar or wire, the member 16 is a cable, and the member 17 is part-cylindrical in cross-section. In Fig. 2b the member 18 comprises a pair of wires, the member 19 is a bar, and the member 20 is horseshoe-shaped. In Fig. 2c, six channels all have different shapes, five are formed on the outside surface of the liner 14 and one is formed on the inside surface of the liner 14.

Fig. 3a shows a liner 21a with four straight longitudinal channels 22. Fig. 3b shows a liner 21b with two parallel helical channels 23 and 24. Fig. 3c shows a liner 21c with one straight channel 25 and two intersecting helical channels 26 and 27.

Thus, the members are located within one or more channels. In a preferred embodiment the channels are axially oriented. Equally, however, they may have wave shapes, radial, winding, or other nonlinear aspects. The channels need not be parallel, i.e., overlaps and inconsistent spacing between channels are permitted.

The shapes of the channels may vary. The shapes are advantageously coordinated with those of the corresponding members. For example, if the member to be disposed in a channel is rounded, such as a cable, a preferred embodiment of the channel cross-section is semicircular, as seen in Fig. 2a. Notwithstanding, channel profiles that are dissimilar to the member(s) are permissible, provided functionality of the system is maintained (per Figs. 2b & 2c).

Not all channels need to be of identical geometry. To accommodate differently sized and shaped members, the channels may have different corresponding cross-sections (per Fig. 2c).

Not all channels need contain members. Although several channels may be present in the inner and/or outer surface of the liner, only a portion of those need contain members (per Fig. 2c).

Not all members utilized in a liner need be identical in geometry or construction. As explained below, individual members may have different functions, so that the respective members may provide different corresponding benefits to the system. Thus, a variety of member types may be introduced into a single liner (per Figs. 2a-2c).

Current liner systems are normally inserted into a host tubular by applying a tensile load from one end, e.g., pull-cables, or gravity weights. Further, individual installation segment lengths

As the liner 30, now containing the member 40, is reduced in diameter as it is drawn through the apparatus 34, stresses of the reduction process will attempt to reduce the channel cross-section

With the invention, the member(s) can be recovered, for reuse, for example. When the liner is inserted by the diametric reduction techniques, and subsequently the tension is released, it spontaneously expands radially. Concurrently, due to the geometry change, the clamping/adhesion

experienced by the member within the channel, is relaxed (per **Fig. 5c**). Resistance to shear between the member and liner is greatly reduced. After the liner has been secured in position within the host tubular, tensile force can be applied to the member alone, pulling it through its channel, and out of the lined tubular system.

If the aforementioned process has used heat, i.e., melting and solidification (as in **Fig. 7c**), to improve adhesion, the process can be reversed. In the case of a cable, electric power can be fed once again through the cable, heating up the liner and/or bonding layer, thus freeing the member for withdrawal while the polymer is melted.

If the aforementioned process has used barbs to gain improved adhesion, the orientation of the barbs within the channels can be so arranged that upon release from compression the barbs can be withdrawn readily (per **Fig. 7b**), thus releasing the cable from the liner.

**Figs. 18a and 18b** show an alternate embodiment wherein a non-channeled liner 100 is inserted in a tubular 102. Adhered to the liner 100 are elongated members 104, 106, which may be electrically conductive and/or resistive if desired (see **Fig. 19** below), in addition to having the mechanical characteristics mentioned above. In this example, member 104 is secured to the liner by an adhesive or heat, for example, while the member 106 is secured to the liner by barbs. As shown in **Fig. 18b**, after pressurization the liner 100 engages the tubular 102 and the members 104, 106 deform the liner 100, thereby defining fluid flow passages.

The advantages of the embodiment of **Figs. 18a and 18b** are the same as those described above.

One of the most important benefits of the invention is that of extending the functional limits of the channels themselves, i.e., expanding the window of allowable operating conditions in which the channels can be used to improve the longevity of a given liner material. In the Roach & Whitehead patent, liner grooves are used in a monitoring and leak detection system. In other patent disclosures filed by the current inventor, channels are used to vent annular fluid to mitigate liner collapse potential, due for example to pressure imbalances, at line shutdown for example. Their effectiveness in these applications is limited by the properties and performance of the materials under the given operating conditions, however. In general, increased pressure will hasten the collapse of the channels, and thus reduce the cross-sectional area of the annular passage surrounding the liner, within the host pipe. This effect is compounded by temperature, as the liner material both softens and expands; reducing resistance to collapse, and expanding to fill the void of the channel itself. See **Figs. 9a and 9b**, which are end cutaway sections of channeled liner 50 in a host 10, before and after the channel 51 contracts due to material expansion. Yet another deleterious effect, particularly for polyethylene liners in hydrocarbon service, is liner material swelling when it reacts upon contact with the fluid carried in the liner bore. This has the same effect as temperature, softening the material and causing it to expand; both detrimental to the geometry and function of the channel for the application.

However, members installed in channels can act as supports to resist the cross-sectional area reduction. See Fig. 10, which is a cutaway end section of a member 52 in a liner channel 51. Preferred embodiments of the members in this case are cables, and/or helical springs.

Installation of either cables or spring members is readily accomplished. In one embodiment they are paid off a reel 53 adjacent to any installation equipment (34 in this example) at the liner entry point, and press-fitting into the channel 54 with a wheel (per Fig. 11).

Generally, the outward radial load due to pressure from within the liner is transmitted to the host pipe which resists the resultant hoop (radial) stress of the system. The force is transmitted both through the liner to the host, and, through the liner, then the member, to the host. The member therefore provides active resistance to collapse of the channel. However, for the channel to function as a fluid pathway, the member should not occupy the entire channel. With suitable member construction and geometry employed, sufficient cross sectional area can be maintained for venting and/or other fluid communication.

In one embodiment (see Fig. 12a), sufficient clear space is available between the member, and the liner at the outer surface of the liner even after pressurization (see Fig. 12d). (Although Figs. 12a and 12d show a cable-type member, the same advantages apply to a bar-type member.) In another, space is made available within the member (see Fig. 12b and 12e), in which the member is a helical spring. The teachings of Figs. 12b and 12e apply as well to members having hollow sections, interstitial openings, for example between cable fiber strands, etc. A member may also be an open section, e.g., a semicircular arch (see Fig. 12c and 12f). Members comprising hollow or open sections may be either solid or perforated.

Generally speaking, continuity may be provided by making the member of an effectively porous material, or by providing the member with lateral and longitudinal openings or perforations (such as a hollow member, a spring, or a cable with interstitial areas between the cable fiber strands) so as to permit fluid flow both into and along the member. In order to facilitate fluid flow, the member should not effect a seal which would prevent fluid permeating through the liner from reaching the annular pathway, or channel. Such a seal may occur, for example, when a solid semicircular member seated in a liner channel (see Fig. 12c) is displaced radially outward into intimate contact with the host pipe as the liner bore pressure is increased (see Fig. 12f). The edges of the member may intimately contact the host pipe, thus preventing permeating fluids from reaching the channel. In view of such considerations, therefore, a desirable alternative is to use a functionally porous member. In the above examples, the porous member may be a multi-strand cable or helical spring. Equally effectively, the desired porosity can be obtained by using a member made of an inherently porous material.

There are potential difficulties with braided members owing to installation technique, particularly when a diametric reduction method is used. Upon unloading tensile insertion stress from a liner/member system, the liner will simultaneously expand radially and contract longitudinally,



attempting to revert to its original geometry, or lowest potential energy. In some cases, the degree of liner contraction may be significantly greater than that of the member, particularly if the aforementioned affixation methods are not suitably employed. Localized differential slipping between the liner and the member may occur. In the case of a braided member, a 'birdcage' will form (see Fig. 13). If such occurrence is undesirable, it is best not to affix the member to the liner during installation. Rather, the member should be inserted into the liner channel relatively loosely, for minimal shear between the liner channel and the member, thus minimizing the potential for this problem to occur.

The use of a helical spring as the member within the channels is a highly preferred embodiment. It overcomes the potential difficulty with braided members discussed above. The spring member may be installed, tightly, at virtually any time in a multi-step or otherwise extensive diametric reduction process, and it can expand and contract with the liner through its loading, unloading and temperature cycles. The spring member concept may be less effective than a cable member, for example, in the extended insertion method described earlier, in which the cable protects the polyethylene liner from the stress of insertion, unless the spring constant of the helical spring is greater than the modulus of elasticity of the liner. However, the helical spring is highly effective for holding the channel open to maintain channel clearance. See Figs 12b and 12e. The member, as seen in transverse cross section, mimics a hollow tube, providing ample means for fluid movement and/or communication. In a longitudinal cross section, space between individual coils provides adequate area to receive annular fluids laterally into the member. Initially the spring member provides active resistance in support of the liner channel (Fig. 12b). When the operating pressure increases sufficiently, the spring member will reorient itself, assuming a lower vertical dimension (Fig. 12e), i.e., radially with respect to the liner/host system. The assumption of such a profile provides another threshold of effective resistance to liner channel collapse. Although the cross-sectional area will be somewhat diminished in this geometry, it will remain effective for its intended purpose.

In addition to the benefits above, i.e., allowing longer insertion lengths and holding the channel open, cable-type members have further advantages.

Specifically, a member located in the channel can be manufactured of an electrically and/or optically conductive material, e.g., conductive or fiberoptic cable. Thus, it can be used to carry electricity and/or data communications from end-to-end.

As described earlier, channel geometry may be designed to allow the cable to remain recessed within the liner channel during installation (see Figs. 8a-8b). This affords the cable member protection, overcoming concerns regarding integrity.

Electrically conductive members may be used to supply electric power and data to remote locations. This is a benefit in many applications. It is well illustrated by an offshore production pipeline. An important utility of the electrically conductive member is gained when the member is

Fig. 14 shows a host pipe 60 with a liner 71 containing electrically conductive cable members 61-68. Note that members 64 and 65, for example, are disposed in a single channel in this embodiment. They are electrically discontinuous as shown, but can be mechanically connected by a suitable insulator or insulating material so that the combined members 64 and 65 can perform the mechanical pulling functions described hereinabove. Members 63, 64 are connected to a power source 69 for supplying power to a heating element 70 within the liner 71. A second power source 72 is connected by members 67, 68 to a second heating element 73. Members 61, 62, 65 and 66 are not used for electrical connections in this embodiment.

**Fig. 19** shows another embodiment which has elongated heating elements 110, 112, 114, such as resistance wires, rather than conductive polymer sheet material. In other respects, the embodiment of Fig. 19 is the same as that in **Figs. 14-15b**. The heating elements are disposed longitudinally, possibly in channels formed in the liner. The respective conductors and heating elements can be disposed either in the same channels or in different, possibly adjacent channels.

Similarly, with the electrically and/or optically conductive member 74, data transmission capabilities may be readily effected, with similar benefits.

Another important application for the invention as related to data transmission is in petroleum exploration, specifically enhancing 'measurement while drilling' systems. See Fig. 22 in PCT/US99/—, referenced above. Currently, large quantities of acquired data are generally stored in downhole tools and analyzed upon withdrawal of the string of tubulars. This is because 'real-time' data transmission rates are extremely slow, e.g., 50 baud, due to acoustic signal attenuation when

the drilling fluid is used as the communications medium. A conductive cable member, deployed in a liner channel, and fully protected by the liner and the host tubular, permits a highly desirable increase the data stream rate, e.g., to 56K baud or more. The member(s) and liner may be inserted in a single long section of tubing, e.g., 25,000 feet long for example, for drilling with continuous coiled tubing. Alternatively, they may be inserted in conventional tubing lengths, with couplings known in the art being provided to maintain signal continuity in the joint areas. The same methodology can be applied to essentially horizontal tubulars, e.g., pipelines connected in series.

In addition to promoting improved fluid flow properties, by assisting in heating the liner as described above, conductive members may also be employed to reduce/remove blockages in the pipeline such as hydrates and/or wax accumulations. In such an instance, the location of the blockage is determined (as shown for example in the cross-referenced patent disclosures) and then electrical power is applied to heat the problematic area, as described above. This reduces the blockage by melting or subliming it, permitting flow to resume normally.

The current invention also allows cable type members disposed within the channels to be used to locate blockages in the line, primarily by means of two important features. First, as described above, the channel provides a protective close-tolerance envelope during installation for the members required locate blockages. Second, signal characteristics, electrical or optical, through said members change in conjunction with changes in the operating conditions in the pipeline. Accordingly, signal data, which is indicative of specific sets of operating conditions, is obtained and analyzed to predict the location of the problem.

By illustration, when the line shifts from normal operations mode, i.e., a fully flowing line, to that when a blockage forms, the physical stresses felt by the member are also changed. The portion of the member upstream of the blockage will be under greater compressive stress than the area downstream, due to higher line pressure transmitted through both liner and member, as discussed above.

Electric strain gauge characteristics, known to the art, may be employed in the electrically conductive member. Electrical resistance of the member will vary in accordance with stress. See Fig. 16. In this embodiment, a cable member 90, disposed in a channel helically oriented along the length of the liner, is both stretched and compressed upstream of the blockage, in area "B." Downstream, in area "A," pressure and tension are not so pronounced. Fig. 16a-16d are isometric schematic and cutaway views illustrating differential stress configurations on the member. Both types of distortion affect the transmission properties of the cable member, i.e., differential resistance. The data can be compared to baseline resistance for analysis and blockage location determination. In order to further refine the accuracy of location, pressures upstream and downstream of the blockage may also be manipulated.

The following is a description of the blockage detection feature of the invention, as illustrated in the schematic of Figs. 16a-16d.



Unlike the electrically conductive case, however, the preferred embodiment is that the fibre optic members be laid in a relatively straight fashion in the annulus, parallel to the longitudinal axis.

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This is to minimize compounding of torsional stresses upon insertion, and to minimize cost. Notwithstanding, other layouts, such as the helically wound one mentioned above will be functional.

Although embodiments of the invention have been described herein, the invention is not limited to such embodiments, but rather includes all modifications and variations that may occur to one having the ordinary level of skill in the art.

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WHAT IS CLAIMED IS:

1. A method of assembling a tubular system,  
the tubular system comprising a tubular; a liner in the tubular, the liner having an outer wall engaging an inner wall of the tubular, the liner having an inner wall defining a hollow bore; and at least one elongated member which is disposed between said liner and said tubular and defines a fluid flow passage between said liner and said tubular;  
said method comprising the steps of:  
placing said liner and said member in contact with each other;  
while said liner and said member are in contact, pulling on said elongated member in order to pull said liner and said elongated member together into said tubular.
2. The method of claim 1, wherein after said pulling step, said member is disposed between said outer liner surface and said tubular and thereby deforms said liner so as to define said fluid flow passage.
3. The method of claim 1, wherein said member is disposed in a channel which is formed in a surface of said liner.
4. The method of claim 1, further comprising the steps of:  
placing a predetermined initial stress on said liner so as to induce a strain; and then  
adhering said liner and said member to each other;  
wherein in said pulling step, said liner is pulled along with said member into said tubular without inducing substantial additional strain on said liner.
5. The method of claim 4, wherein said adhering step comprises the step of providing barbs on said member.
6. The method of claim 4, wherein said adhering step comprises the step of applying heat to said member.
7. The method of claim 6, wherein said adhering step further comprises the step of applying an adhesive between said member and said liner.

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8. The method of claim 6, wherein said heat is applied by passing an electric current through said member.

9. The method of claim 6, wherein said heat is applied by radiation from the exterior of said liner.

10. The method of claim 4, wherein said adhering step comprises the step of applying an adhesive between said member and said liner.

11. The method of claim 4,  
wherein said member is disposed in a channel which is formed in said outer surface of said liner, and

wherein said adhering step comprises the steps of disposing said member in said channel, then radially compressing the liner so that said channel grips said member.

12. The method of claim 11, wherein said member comprises a cable.

13. The method of claim 11, wherein said member comprises a generally helical spring.

14. The method of claim 13, wherein said spring has a spring constant which is stiffer than a modulus of elasticity of said liner so that said liner is pulled by said member into said tubular without placing substantial additional strain on said liner.

15. The method of claim 11, wherein said member when in said channel is disposed fully inside said outer surface of said liner.

16. The method of claim 15, wherein said member is adhered to said liner sufficiently to remain in said channel.

17. The method of claim 11, wherein said member is adhered to said liner sufficiently to remain in said channel.

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18. The method of claim 11, further comprising the step of making said member of a sufficiently strong material to resist deformation of said channel due to increased pressure in said liner bore.

19. The method of claim 11, further comprising the step of making said member of a sufficiently strong material to resist deformation of said channel due to thermal softening of said liner.

20. The method of claim 11, further comprising the step of making said member of a sufficiently strong material to resist deformation of said channel due to swelling of said liner upon contact with materials in said liner bore.

21. A tubular system with internal heating, comprising:

a host tubular;

a liner in the tubular, the liner having an outer wall engaging an inner wall of the tubular, the liner having an inner wall defining a hollow bore; and

at least one electrically conductive elongated member disposed between said host tubular and said liner;

said liner comprising an electrical heating element connected to said at least one member for receiving electrical current from said member and thereby heating said tubular system;

wherein said tubular system is assembled by the steps of:

securing said liner and at least one elongated member to each other; and

then pulling on said member, so that said liner is pulled, along with said member, into said tubular.

22. The tubular system of claim 21, the liner having at least one channel formed therein, said member being disposed in said at least one channel.

23. The tubular system of claim 22, wherein said electrical heating element is a conductive polymer layer which has an electrical resistance and forms a part of said liner.

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24. The tubular system of claim 22, wherein said electrical heating element is an electrically resistive wire disposed in said at least one channel.

25. The tubular system of claim 21, wherein said tubular system is further assembled by the steps of:

placing a predetermined initial stress on said liner so as to induce a strain; and

then pulling on said member, so that said liner is pulled, along with said member, into said tubular without inducing substantial additional strain on said liner.

26. A tubular system with internal heating, comprising:

a host tubular;

a liner in the tubular, the liner having an outer wall engaging an inner wall of the tubular, the liner having an inner wall defining a hollow bore; and

at least one electrically conductive elongated member disposed between said host tubular and said liner;

said liner comprising an electrical heating element connected to said at least one member for receiving electrical current from said member and thereby heating said tubular system;

wherein said member is adhered to said liner and has sufficient tensile strength to be usable to pull said liner into said tubular without inducing substantial strain in said liner.

27. A tubular system adapted for determining the location of a blockage therein, the tubular system comprising:

a tubular;

a liner in the tubular, the liner having at least one channel formed therein; an outer wall of the liner engaging an inner wall of the tubular; the liner having an inner wall defining a hollow bore; and

at least one elongated sensing member which is disposed in said at least one channel and is responsive to pressure in said hollow bore within said liner, and produces a pressure

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of:

placing a predetermined initial stress on said liner so as to induce a strain;  
then adhering said liner to at least one elongated member; and  
then pulling on said member, so that said liner is pulled, along with said member, into said tubular without inducing substantial additional strain on said liner.

35. A method of assembling a tubular system,  
the tubular system comprising a tubular; a liner in the tubular, the liner having an outer wall engaging an inner wall of the tubular, the liner having an inner wall defining a hollow bore; and at least one elongated member which is disposed between said liner and said tubular and defines a fluid flow passage between said liner and said tubular;  
said method comprising the steps of:  
placing said liner and said member in contact with each other;  
while said liner and said member remain in contact, pulling on said elongated member in order to pull said liner and said member together into said tubular.

36. The method of claim 35, wherein said contact between said elongated member and said liner protects said elongated member from deformation while being pulled into said tubular.

37. The method of claim 36, wherein said elongated member comprises a communications cable.

38. The method of claim 36, wherein said elongated member comprises a heating cable.

39. The method of claim 36, wherein said elongated member comprises a force-sensing cable.

40. The method of claim 36, wherein said elongated member comprises an electrical or fluid-carrying conduit.

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41. A method of assembling a tubular system,  
the tubular system comprising a tubular; a liner in the tubular, the liner having an outer wall engaging an inner wall of the tubular, the liner having an inner wall defining a hollow bore; and at least one elongated member which is disposed between said liner and said tubular and defines a fluid flow passage between said liner and said tubular;

said method comprising the steps of:

placing said liner and said member in contact with each other;

while said liner and said member remain in contact, pulling said liner into said tubular;

wherein said contact between said elongated member and said liner protects said elongated member from deformation while being pulled into said tubular;

wherein said member is disposed in a channel which is formed in said outer surface of said liner, and

wherein said adhering step comprises the steps of disposing said member in said channel, then compressing said channel so that said channel grips said elongated member.

42. The method of claim 41, wherein said member and liner are pulled into said tubular with said channel still compressed.

43. The method of claim 41, wherein said channel is compressed by radially compressing said liner.

44. The method of claim 43, wherein said member and said liner are pulled into said tubular with said liner still compressed.

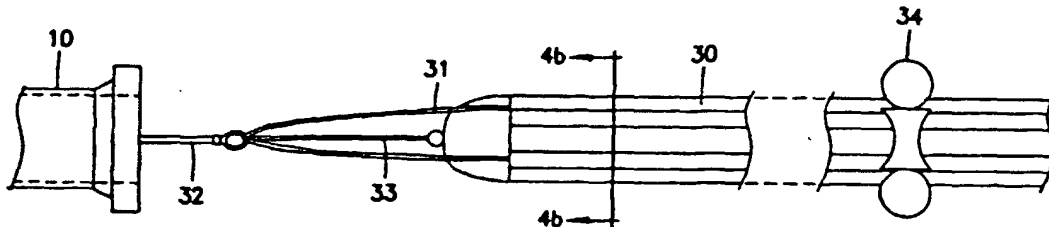
45. The method of claim 11, wherein said member and said liner are pulled into said tubular with said liner still compressed.

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(71) Applicant (for all designated States except US): SAFETY-LINER SYSTEMS, LLC [US/US]; 27286 Jimmy Lane, Conroe, TX 77385 (US).			
(72) Inventors; and (75) Inventors/Applicants (for US only): TAYLOR, Jack, Curtis [US/US]; 27221 Kane Lane, Conroe, TX 77385 (US); ROACH, Max, Jerry [US/US]; 27286 Jimmy Lane, Conroe, TX 77385 (US).		Published With international search report.	
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(54) Title: ENHANCEMENT OF PROFILED TUBULAR LINING SYSTEMS BY CHANNEL AUGMENTATION



**(57) Abstract**

A tubular system made up of a tubular (10), a liner (12) in the tubular (10), and longitudinally oriented members (15, 16, and 17), which may be disposed within the channels in the liner. The members advantageously may be used for pulling a liner into a host tubular, and/or maintaining the structural strength of the liner (12). The members are continuous along the length of the plastic-lined tubular (10), and if applicable, through intermediary joints. The channels may be in the inner and/or outer surfaces of the liner (12). The members may be usable for carrying electrical current or signals, fiberoptic signals, or data communications; for heating the liner; and/or for detecting faults in the liner and/or the host tubular (10).

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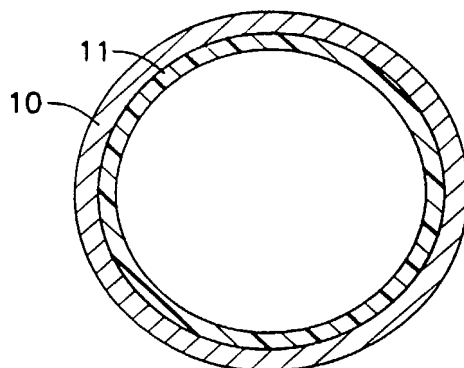


Fig. 1  
Prior Art

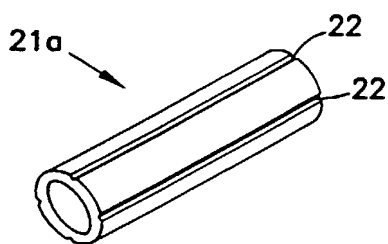


Fig. 3a

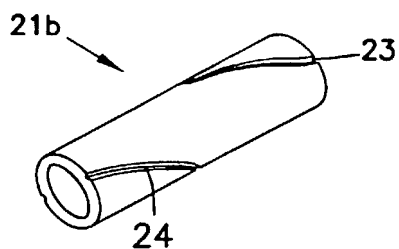


Fig. 3b

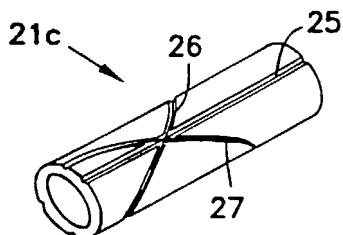


Fig. 3c

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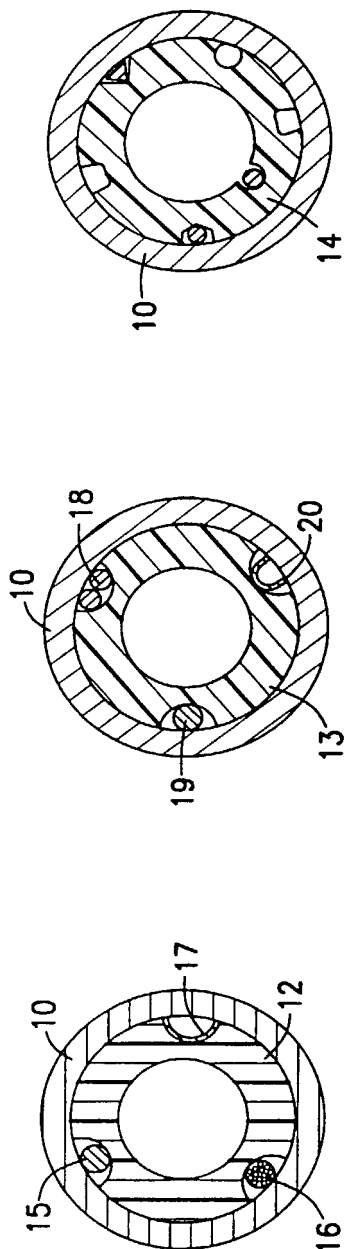


Fig. 2c

Fig. 2b

Fig. 2a



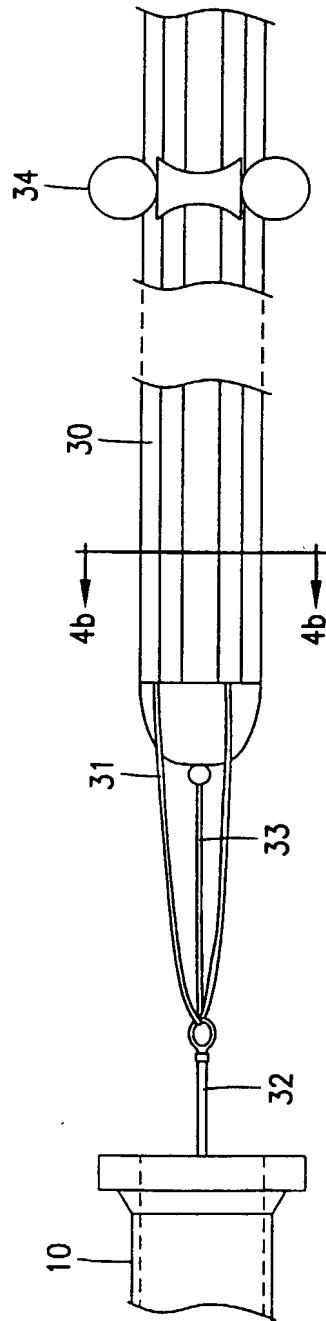


Fig. 4a

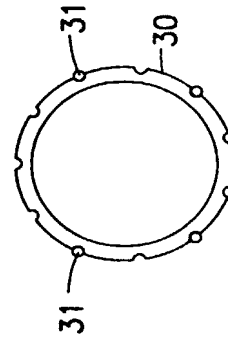


Fig. 4b

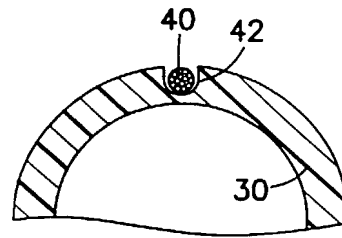


Fig. 5a

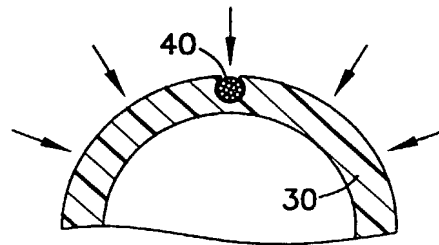


Fig. 5b

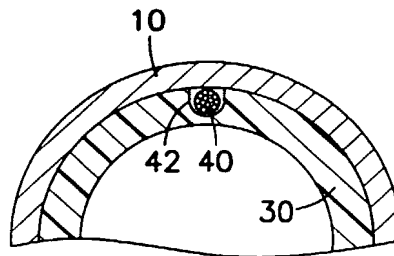


Fig. 5c

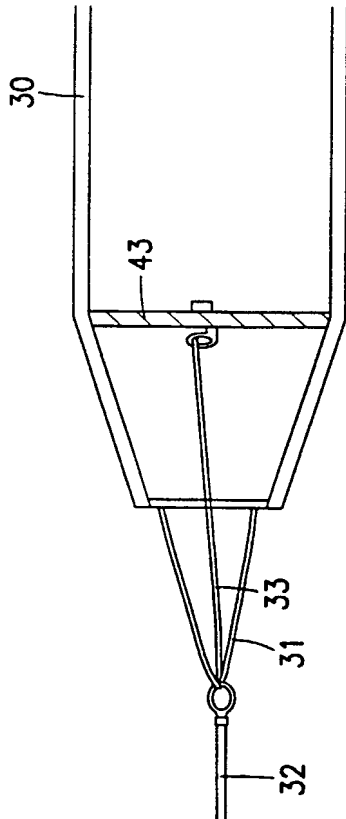


Fig. 6

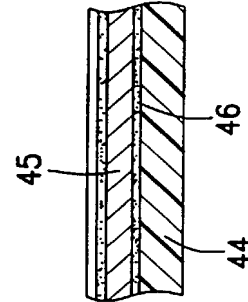


Fig. 7c

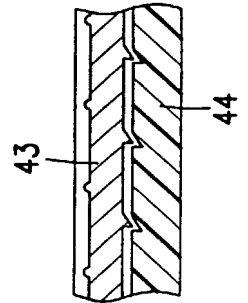


Fig. 7b

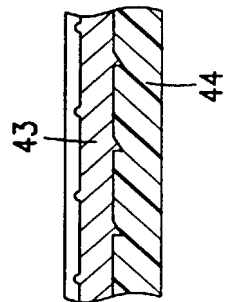


Fig. 7a

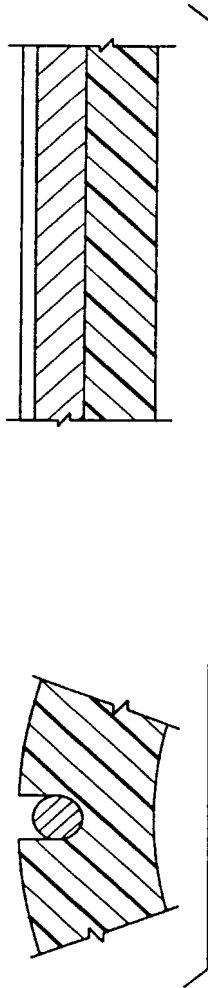


Fig. 8a

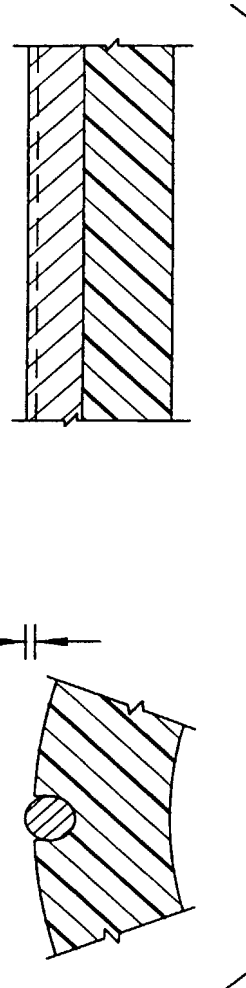


Fig. 8b

Fig. 9b

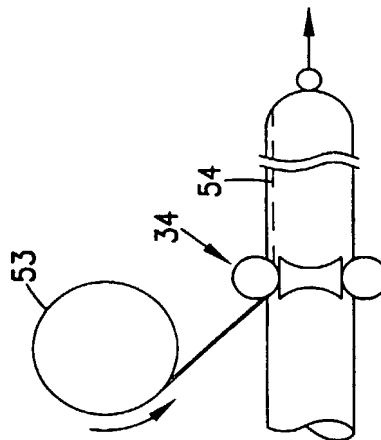


Fig. 11

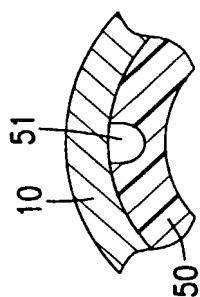


Fig. 9a

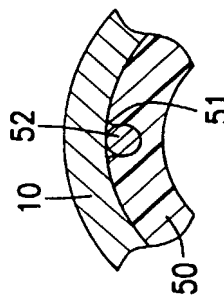


Fig. 10

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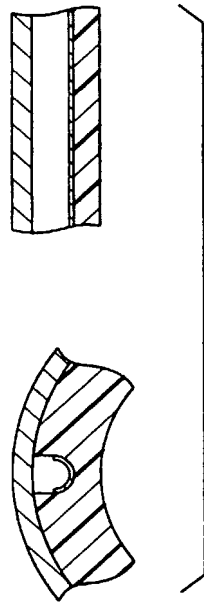


Fig. 12a

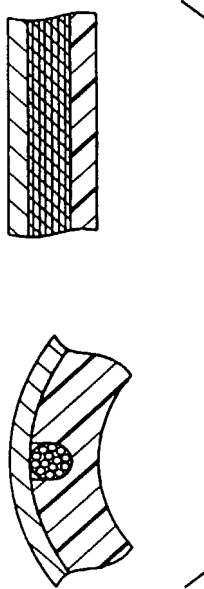


Fig. 12b

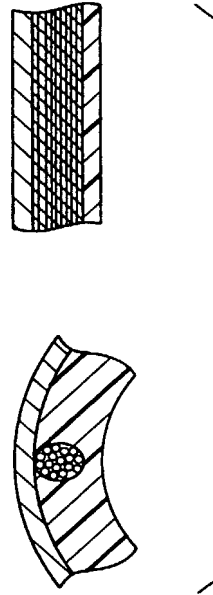


Fig. 12c

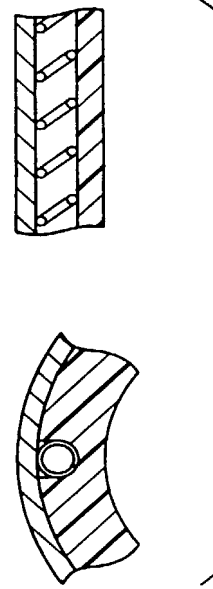


Fig. 12d

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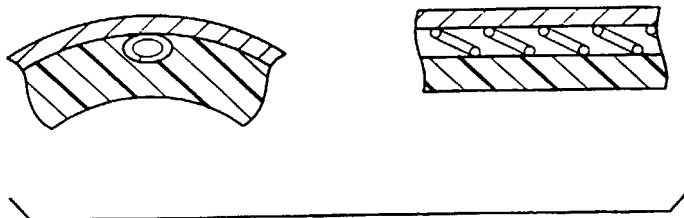


Fig. 12e

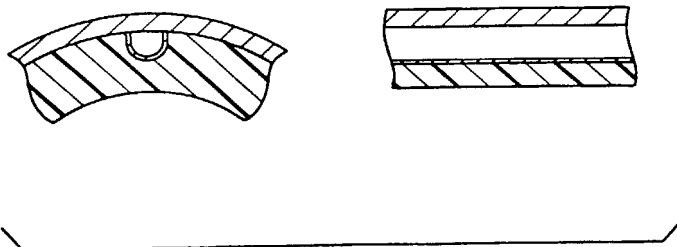


Fig. 12f

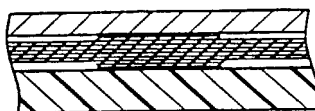


Fig. 13

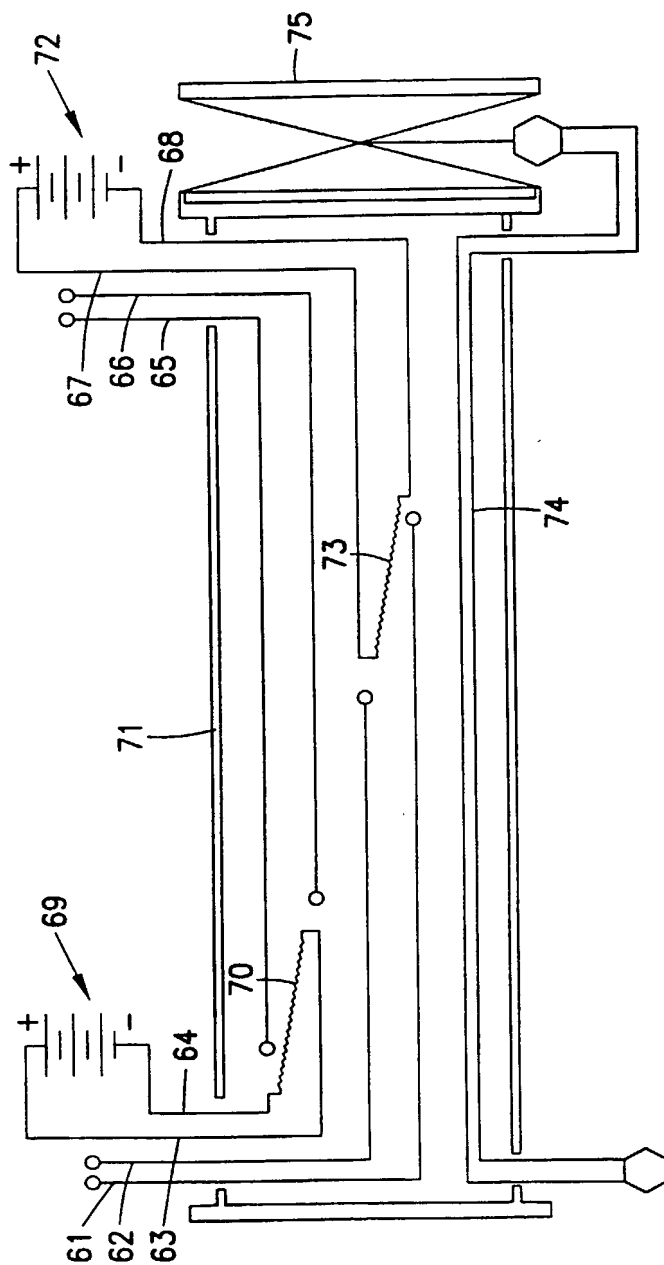


Fig. 14



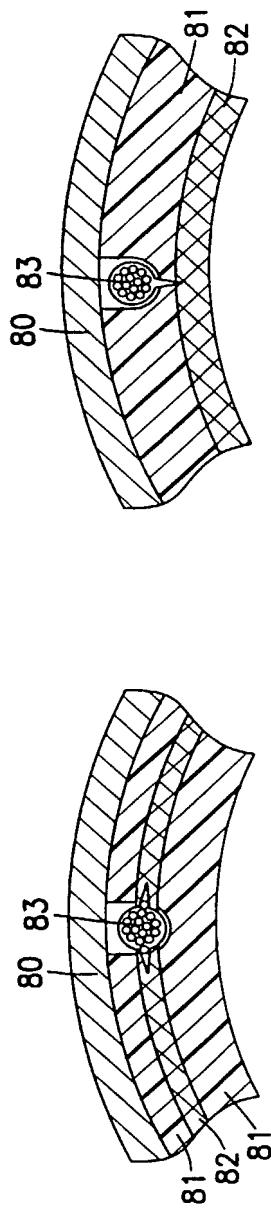


Fig. 15a Fig. 15b

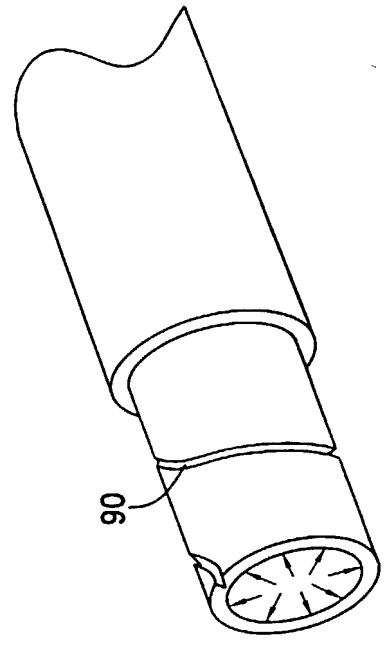


Fig. 16a

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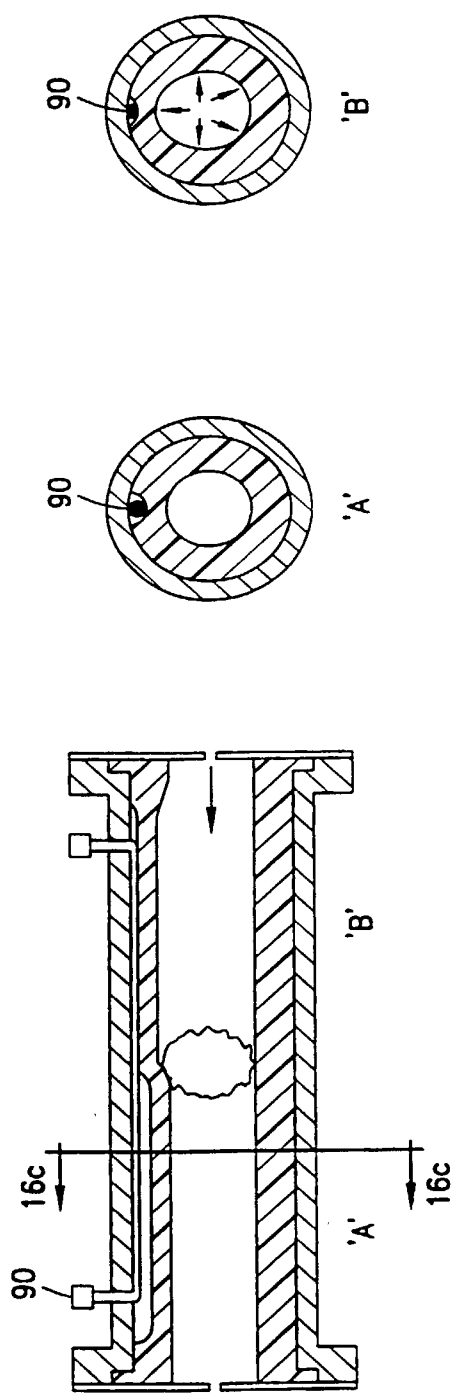


Fig. 16c Fig. 16d

Fig. 16b

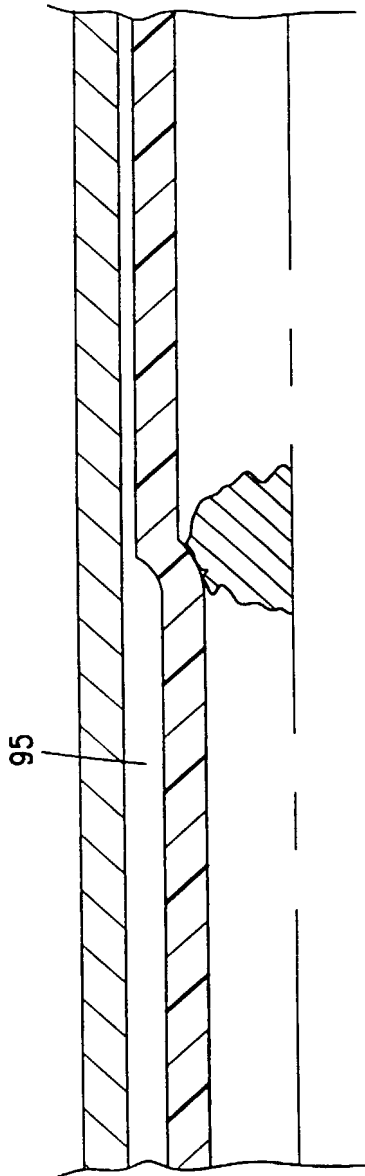


Fig. 17

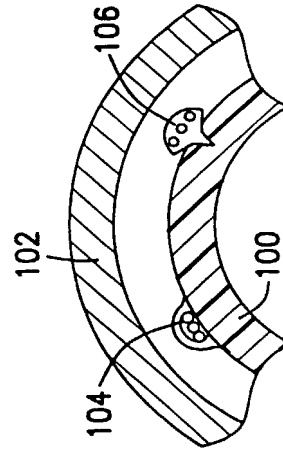
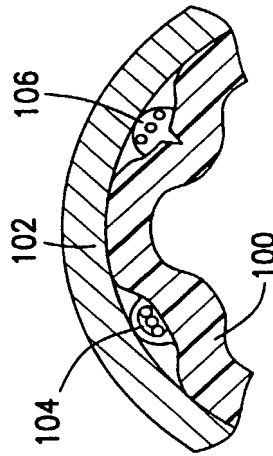


Fig. 18b

Fig. 18a

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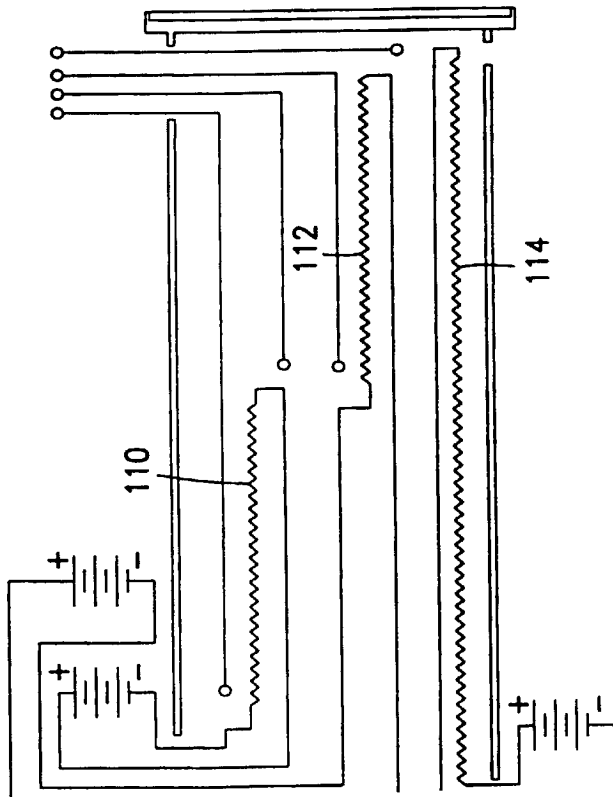
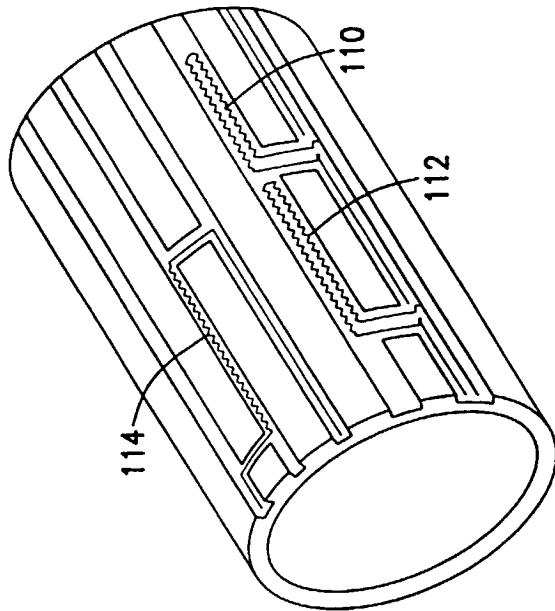


Fig. 19

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name, that I verily believe that I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural inventors are named) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

**ENHANCEMENT OF PROFILED TUBULAR LINING SYSTEMS BY CHANNEL AUGMENTATION**

the specification of which is attached hereto, unless the following box is checked

☒ was filed on 28 July 1999 as United States patent Application Number or PCT International patent application number PCT/US99/16968 and was amended on 11 September, 2000 and 13 November 2000 (if any).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose all information known to be material to patentability in accordance with Title 37, Code of Federal Regulations, § 1.56.

I hereby claim priority benefits under Title 35, United States Code § 119 of any foreign application(s) for patent or inventor's certificate or United States provisional application(s) listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed

Prior Foreign or Provisional Application(s)

COUNTRY	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 U.S.C. 119
U.S.A.	60/094,326	28 July 1998	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/>
			YES <input type="checkbox"/> NO <input type="checkbox"/>

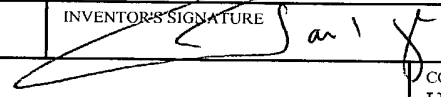
I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application

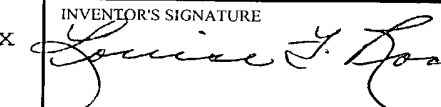
UNITED STATES APPLICATION NUMBER	DATE OF FILING (day, month, year)	STATUS (patented, pending, abandoned)

I hereby appoint customer no. 2352 OSTROLENK, FABER, GERB & SOFFEN, LLP, and the members of the firm, Samuel H. Weiner - Reg. No. 18,510; Jerome M. Berliner - Reg. No. 18,653; Robert C. Faber - Reg. No. 24,322; Edward A. Meilman - Reg. No. 24,735; Stanley H. Lieberstein - Reg. No. 22,400; Steven I. Weisburd - Reg. No. 27,409; Max Moskowitz - Reg. No. 30,576; Stephen A. Soffen - Reg. No. 31,063; James A. Finder - Reg. No. 30,173; William O. Gray, III - Reg. No. 30,944; Louis C. Dymnich - Reg. No. 30,625 and Douglas A. Miro - Reg. No. 31,643, as attorneys with full power of substitution and revocation to prosecute this application, to transact all business in the Patent & Trademark Office connected therewith and to receive all correspondence

SEND CORRESPONDENCE TO: **OSTROLENK, FABER, GERB & SOFFEN, LLP** DIRECT TELEPHONE CALLS TO:  
1180 AVENUE OF THE AMERICAS (212) 382-0700  
NEW YORK, NEW YORK 10036-8403  
CUSTOMER NO. 2352

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon

FULL NAME OF SOLE OR FIRST INVENTOR <u>Jack Curtis TAYLOR</u>	INVENTOR'S SIGNATURE 	DATE <u>MARCH 5, 2001</u>
RESIDENCE (City and either State or Foreign Country) <u>Conroe, Texas TX</u>	COUNTRY OF CITIZENSHIP <u>U.S.A. CANADA</u>	
POST OFFICE ADDRESS <u>27221 Kane Lane, Conroe, TX 77385</u>		

FULL NAME OF SECOND JOINT INVENTOR (IF ANY) <u>Louise F. ROACH, executrix of the estate of Max Jerry ROACH, deceased</u>	INVENTOR'S SIGNATURE 	DATE <u>March 5, 2001</u>
RESIDENCE (City and either State or Foreign Country) <u>Conroe, Texas</u>	COUNTRY OF CITIZENSHIP <u>U.S.A.</u>	
POST OFFICE ADDRESS <u>27286 Jimmy Lane, Conroe, TX 77385</u>		

FULL NAME OF THIRD JOINT INVENTOR (IF ANY)	INVENTOR'S SIGNATURE	DATE
RESIDENCE (City and either State or Foreign Country)	COUNTRY OF CITIZENSHIP	
POST OFFICE ADDRESS		

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UNITED STATES OF AMERICA  
COMBINED DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

OFCS FILE NO.  
P/3501-9

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name, that I verily believe that I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural inventors are named) of the subject matter which is claimed and for which a patent is sought on the invention entitled

ENHANCEMENT OF PROFILED TUBULAR LINING SYSTEMS BY CHANNEL

AUGMENTATION

the specification of which is attached hereto, unless the following box is checked.

☒ was filed on 28 July 1999 as United States patent Application Number or PCT International patent application number PCT/US99/16968 and was amended on 11 September, 2000 and 13 November 2000 (if any).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose all information known to be material to patentability in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim priority benefits under Title 35, United States Code §119 of any foreign application(s) for patent or inventor's certificate or United States provisional application(s) listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed

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COUNTRY	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 U.S.C. 119
U.S.A.	60/094,326	28 July 1998	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/>
			YES <input type="checkbox"/> NO <input type="checkbox"/>

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

UNITED STATES APPLICATION NUMBER	DATE OF FILING (day, month, year)	STATUS (patented, pending, abandoned)

I hereby appoint customer no. 2352 OSTROLENK, FABER, GERB & SOFFEN, LLP, and the members of the firm, Samuel H. Weiner - Reg. No. 18,510; Jerome M. Berlner - Reg. No. 18,653; Robert C. Faber - Reg. No. 24,322; Edward A. Meilman - Reg. No. 24,735; Stanley H. Lieberstein - Reg. No. 22,400; Steven I. Weisburd - Reg. No. 27,409; Max Moskowitz - Reg. No. 30,576; Stephen A. Soffen - Reg. No. 31,063; James A. Finder - Reg. No. 30,173; William O. Gray, III - Reg. No. 30,944; Louis C. Dujmich - Reg. No. 30,625 and Douglas A. Miro - Reg. No. 31,643, as attorneys with full power of substitution and revocation to prosecute this application, to transact all business in the Patent & Trademark Office connected therewith and to receive all correspondence

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NEW YORK, NEW YORK 10036-8403  
CUSTOMER NO. 2352

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon

FULL NAME OF FIRST JOINT INVENTOR <b>Jack Curtis TAYLOR</b>	INVENTOR'S SIGNATURE	DATE
RESIDENCE (City and either State or Foreign Country) <b>Conroe, Texas</b>	COUNTRY OF CITIZENSHIP <b>CANADA</b>	
POST OFFICE ADDRESS <b>27221 Kane Lane, Conroe, TX 77385</b>		
FULL NAME OF SECOND JOINT INVENTOR <b>Max Jerry Roach</b>	INVENTOR'S SIGNATURE	DATE
RESIDENCE (City and either State or Foreign Country) <b>Conroe, Texas TX</b>	COUNTRY OF CITIZENSHIP <b>U.S.A.</b>	
POST OFFICE ADDRESS <b>27286 Jimmy Lane, Conroe, TX 77385</b>		
FULL NAME OF LEGAL REPRESENTATIVE <b>Louise F. ROACH, executrix of the estate of Max Jerry ROACH</b>	SIGNATURE <i>Louise F. Roach</i>	DATE <b>5-15-02</b>
RESIDENCE (City and either State or Foreign Country) <b>Conroe, Texas TX</b>	COUNTRY OF CITIZENSHIP <b>U.S.A.</b>	
POST OFFICE ADDRESS <b>27286 Jimmy Lane, Conroe, TX 77385</b>		

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